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Hsu et al.

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(54) **BONDING STRUCTURE OF CIRCUIT SUBSTRATE FOR INSTANT CIRCUIT INSPECTING**

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(22) Filed: **May 7, 2010**

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Related U.S. Application Data

(63) Continuation of application No. 11/905,439, filed on Oct. 1, 2007, now Pat. No. 7,919,782.

(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**
H01L 23/58 (2006.01)

(52) **U.S. Cl.** **257/48**; 257/59; 257/459; 349/145

(58) **Field of Classification Search** 257/59, 257/89, 459; 349/145
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

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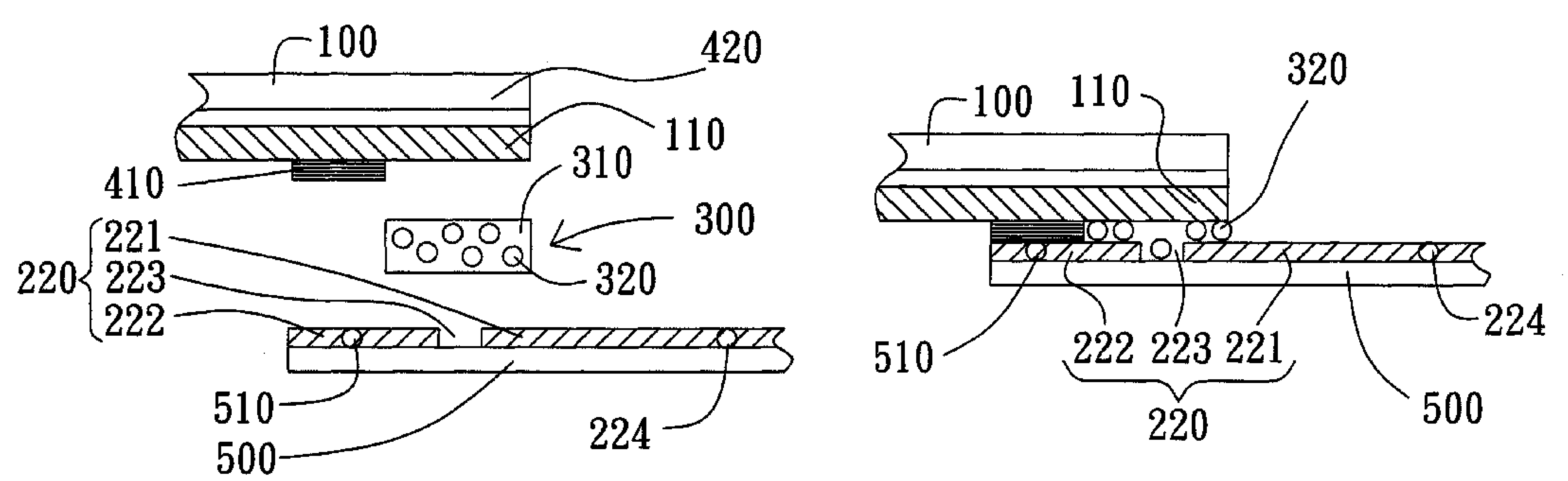
(57) **ABSTRACT**

The present invention provides a bonding structure of circuit substrates for instant circuit inspecting. The connecting wire design of the bonding structure has an instant inspection ability of circuit connection in bonding two circuit substrates. In two bonded circuit substrates, the signal inputted at the circuit part passes the conductive particles to the first connecting wire, and then passes the conductive particles again to the detecting part from the first connecting wire. Therefore, measuring the output signal can inspect the reliability of the circuit connection of the bonded circuit substrates. If the output signal is the same as the input signal, the bonding structure between the first connecting wire and the circuit part is validated, or, if not, the bonding structure is invalidated.

6 Claims, 6 Drawing Sheets



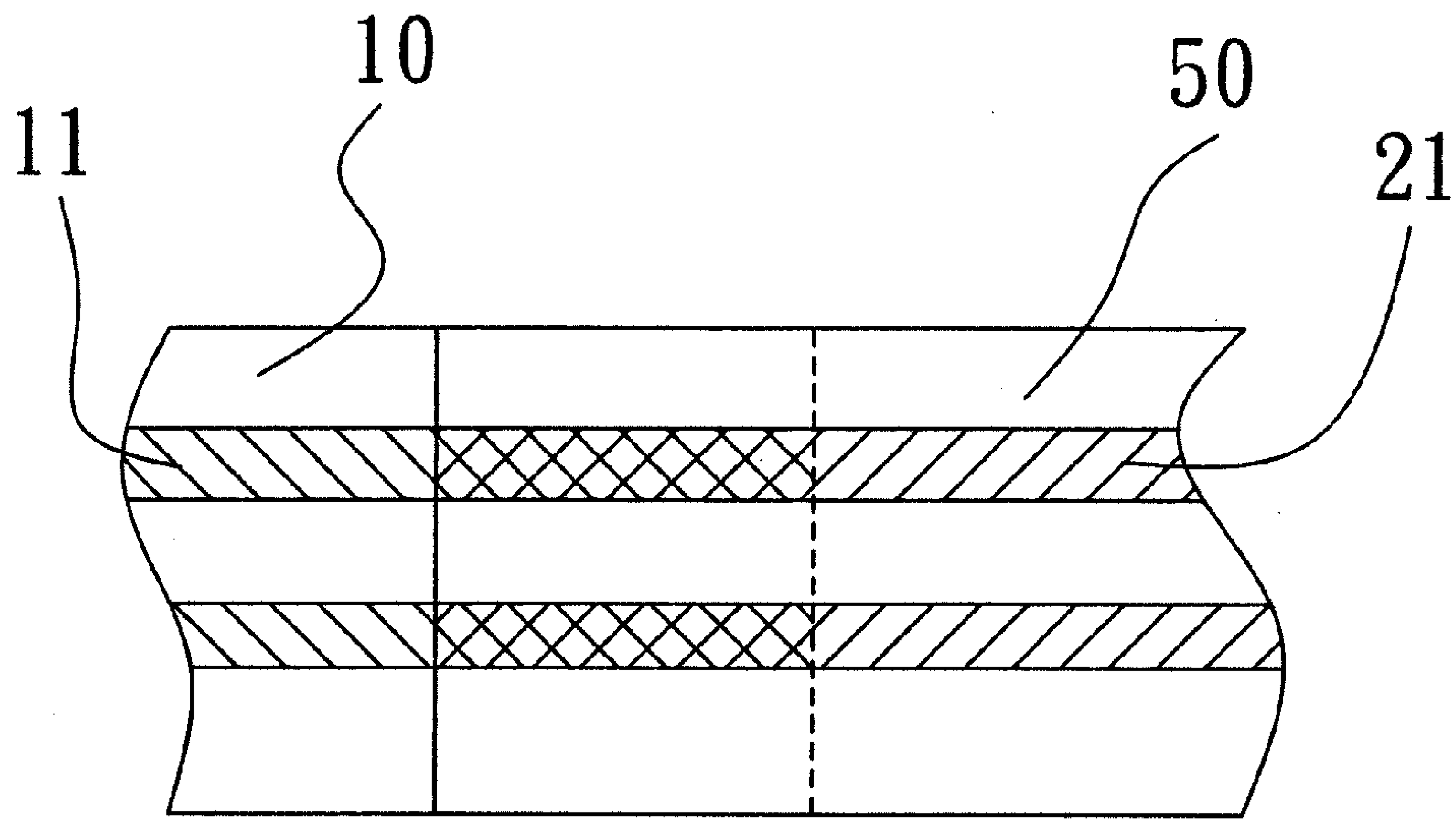


Fig. 1 (Prior Art)

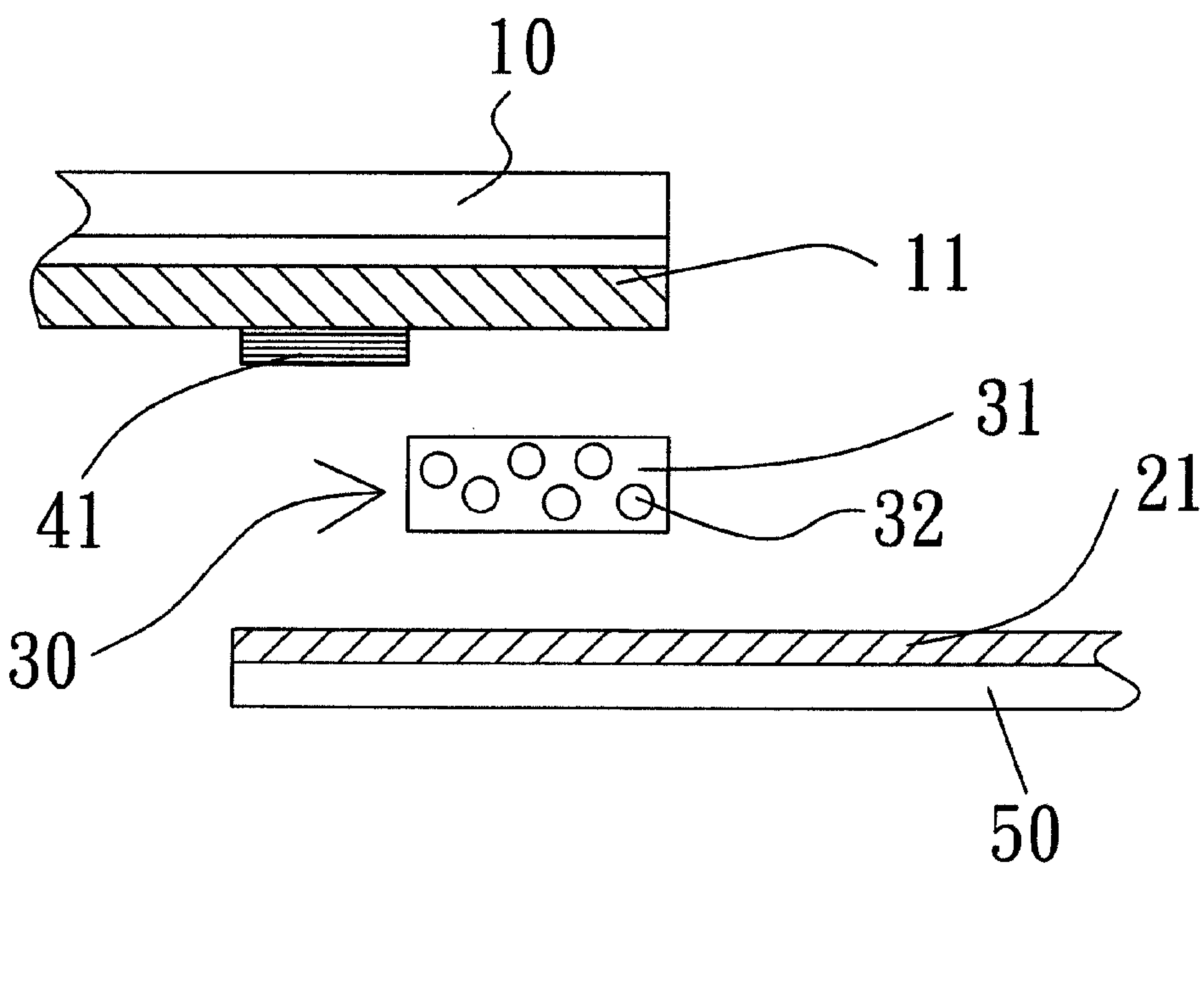


Fig. 2 (Prior Art)

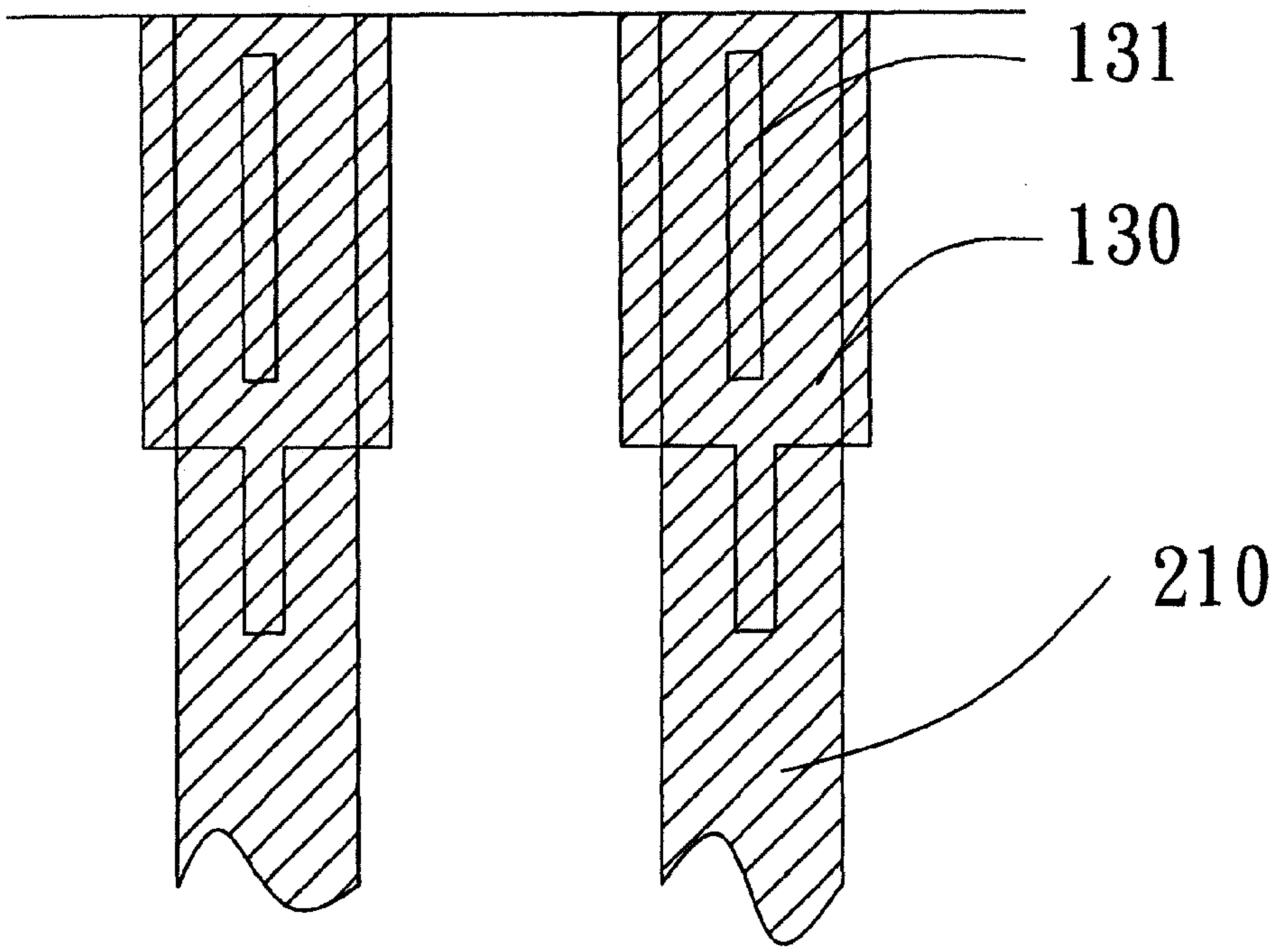


Fig. 3 (Prior Art)

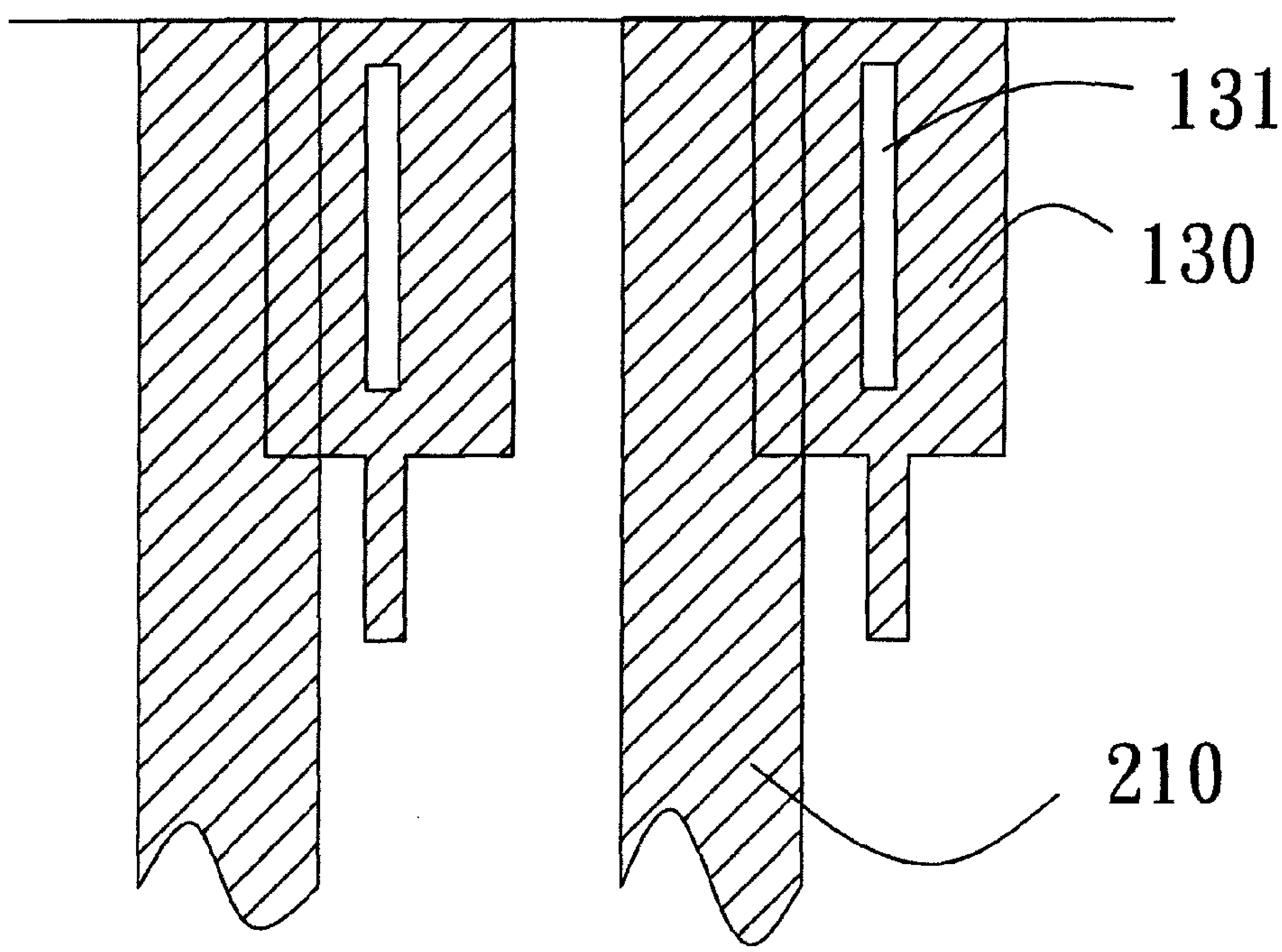


Fig. 4 (Prior Art)

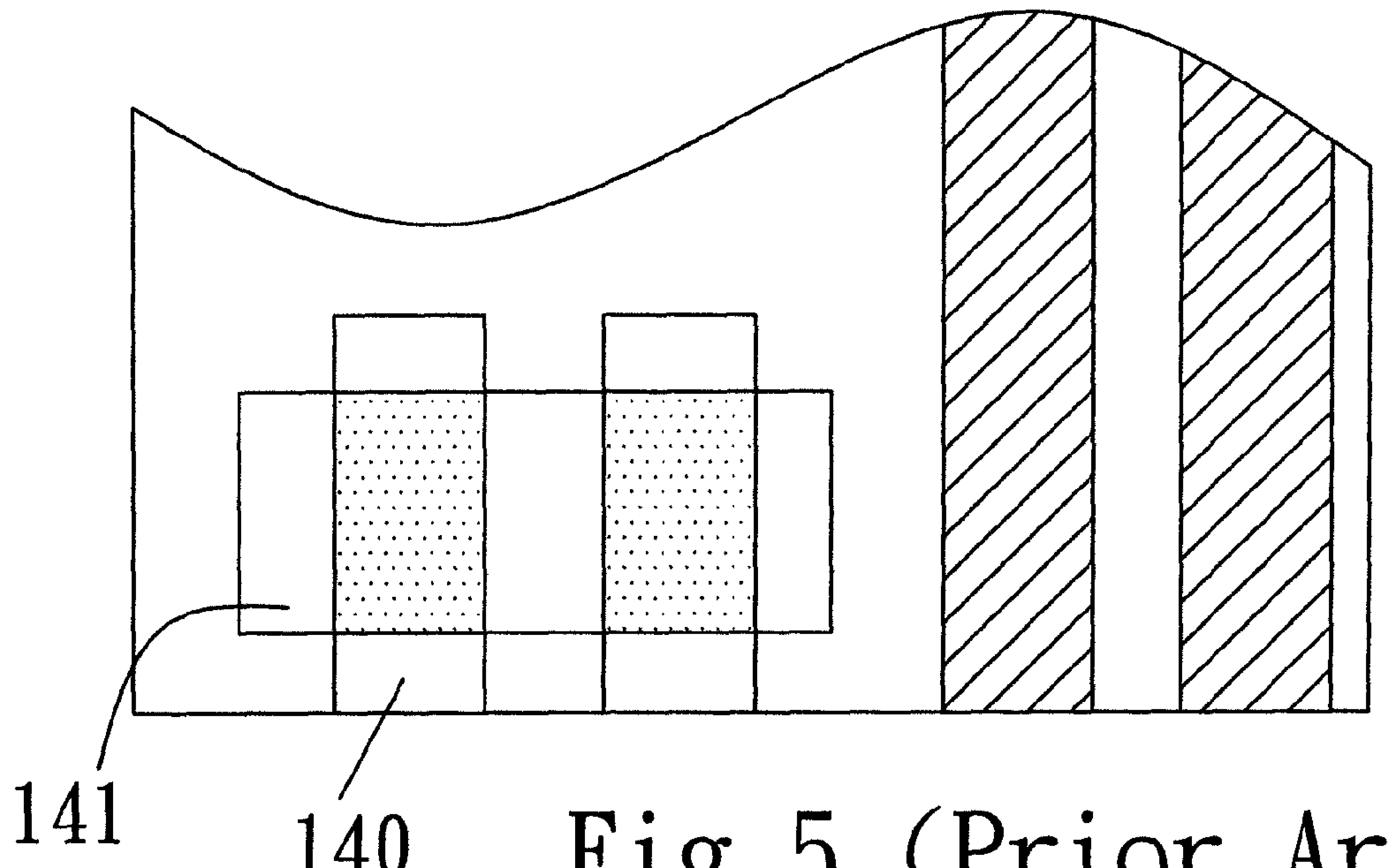


Fig. 5 (Prior Art)

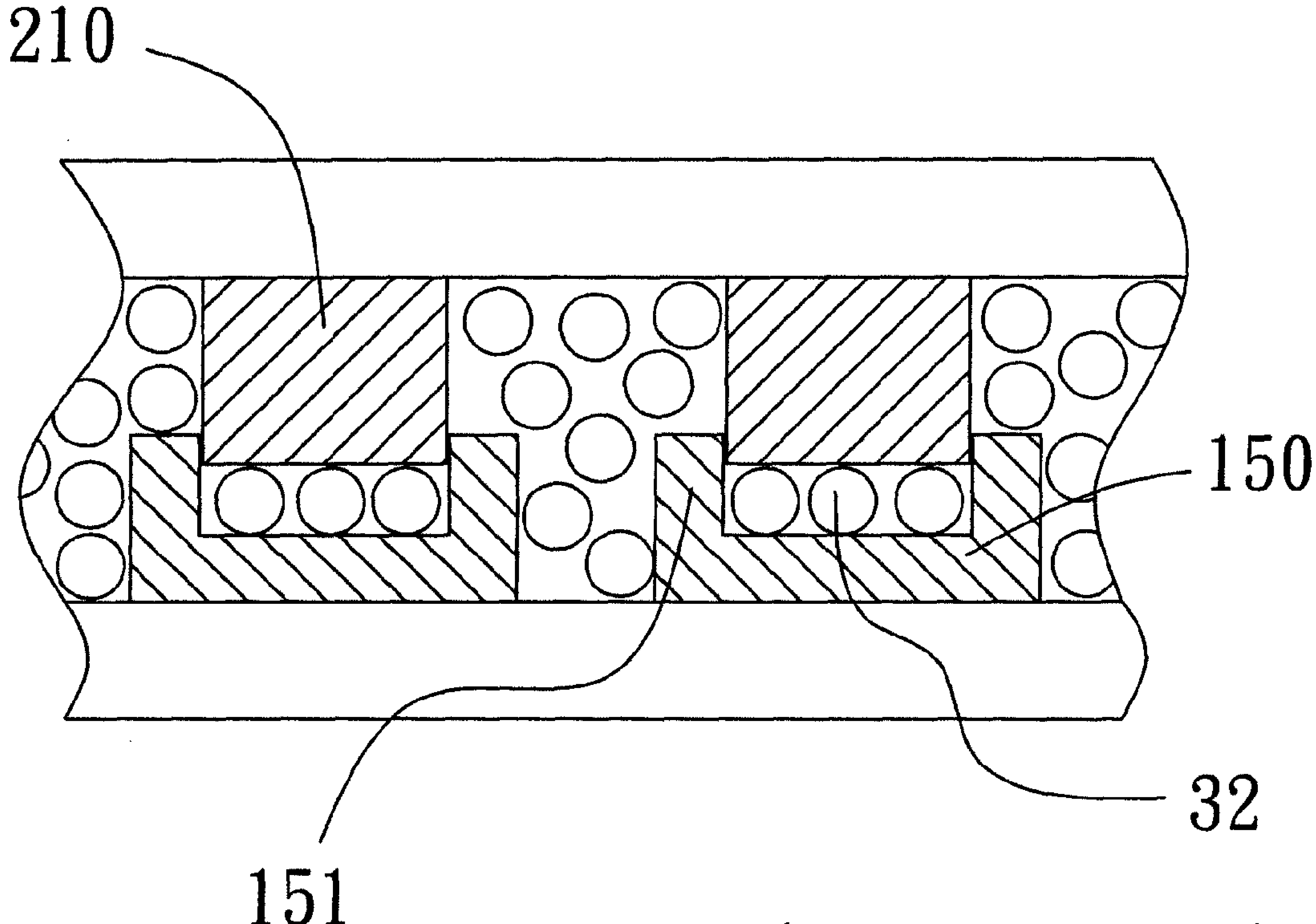


Fig. 6 (Prior Art)

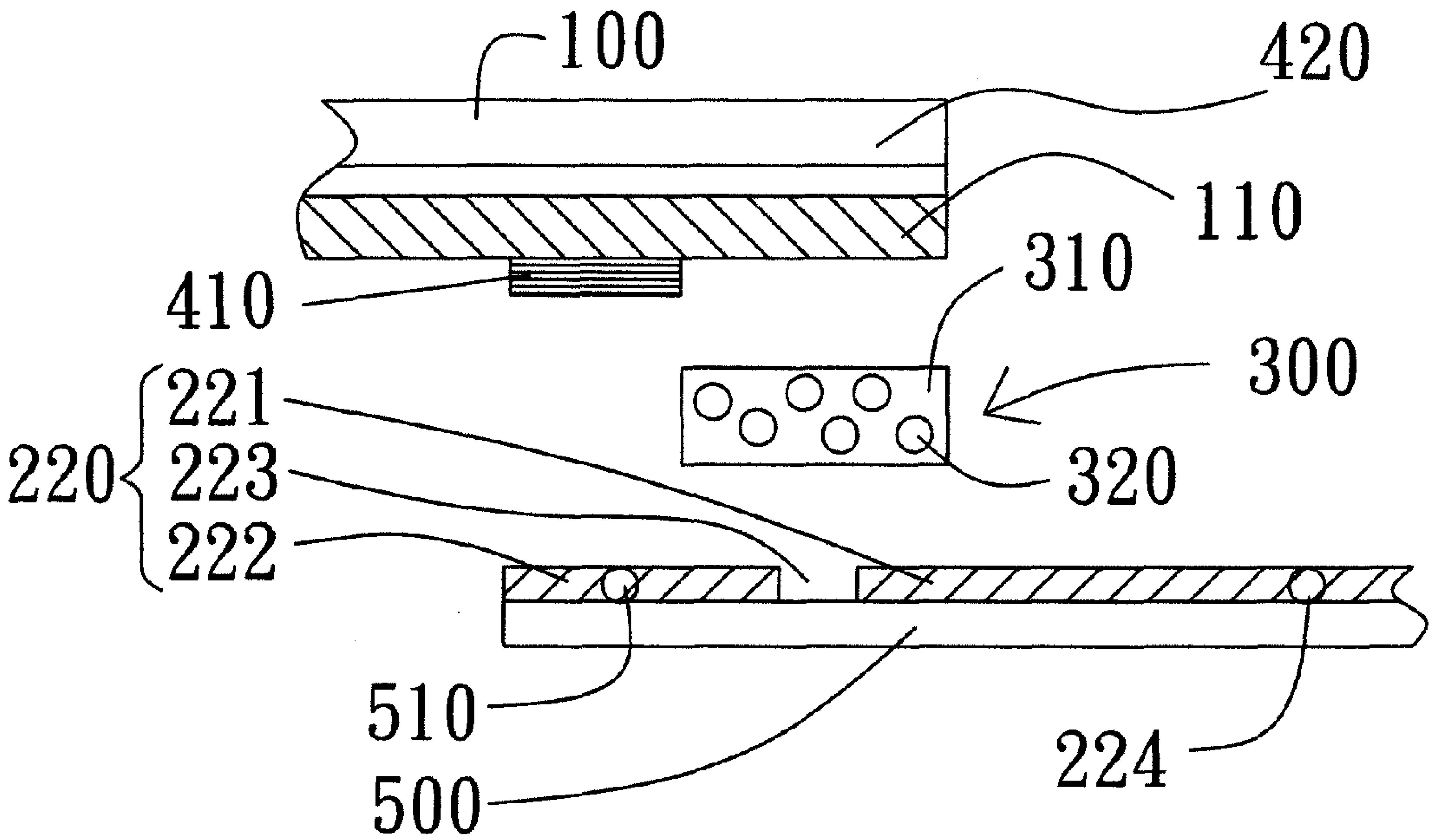

100
420
110
410
310
300
220
221
223
222
320
510
224
500

Fig. 7

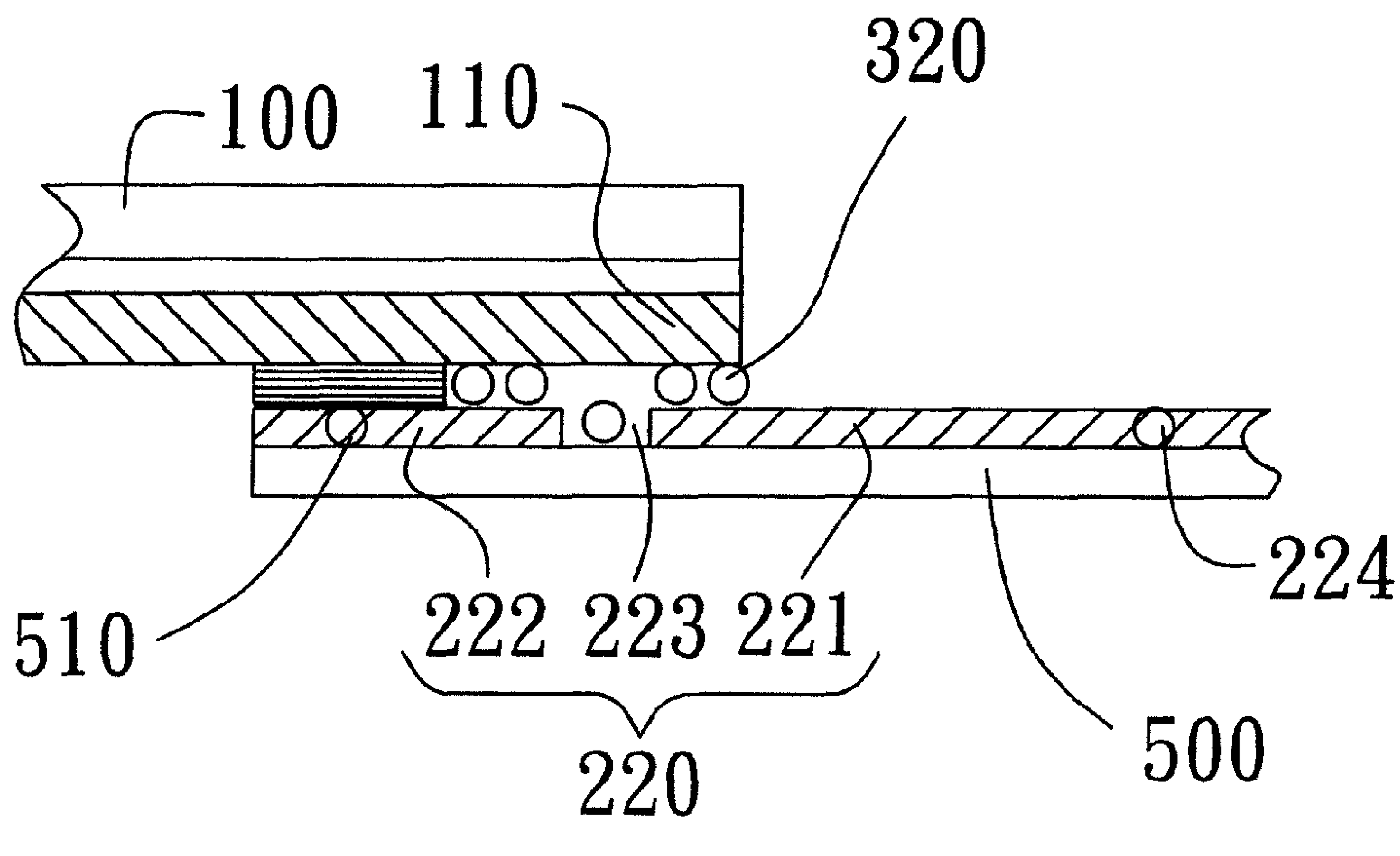

320
100
110
510
222
223
221
224
220
500

Fig. 8

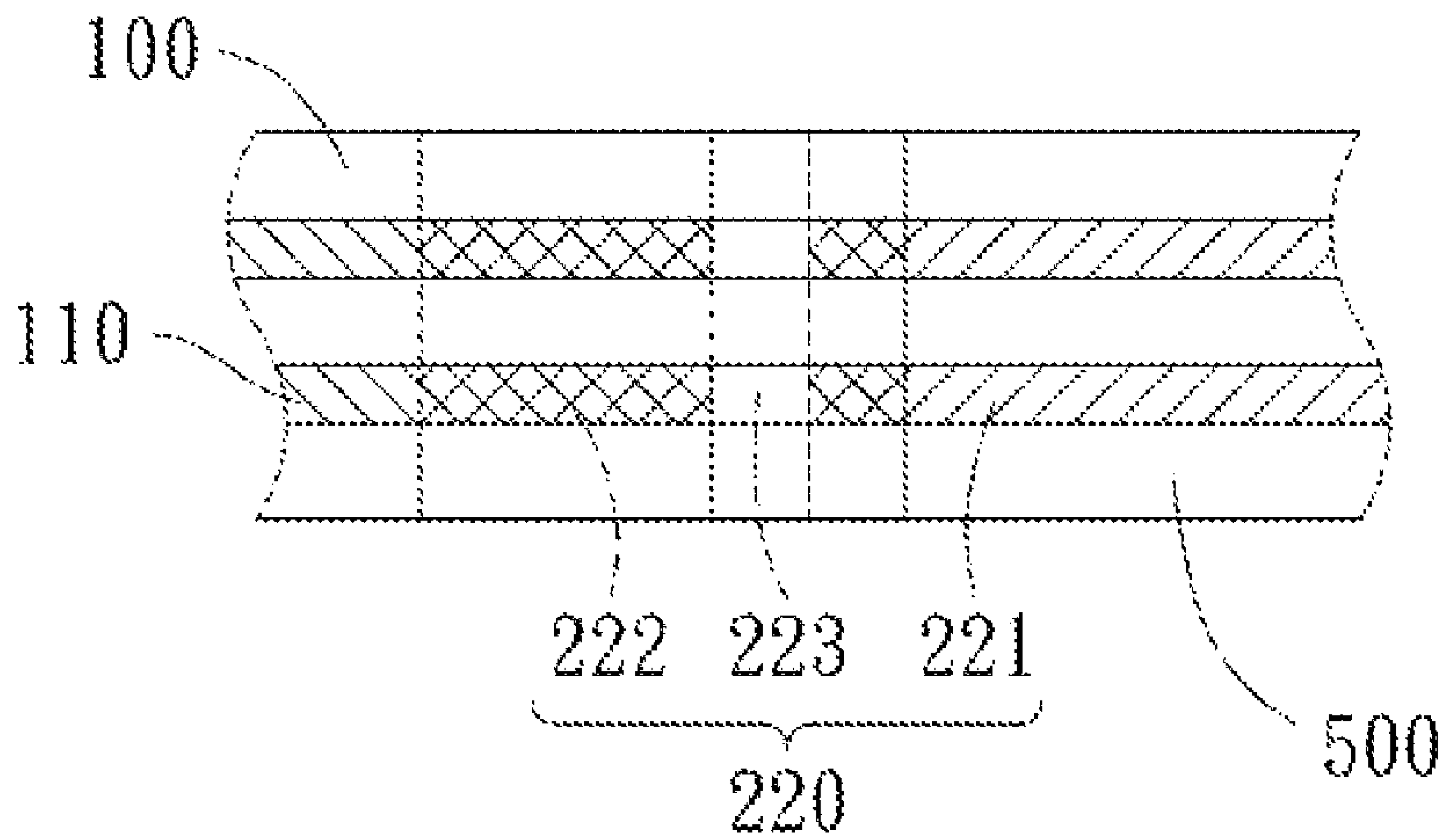


Fig. 8a

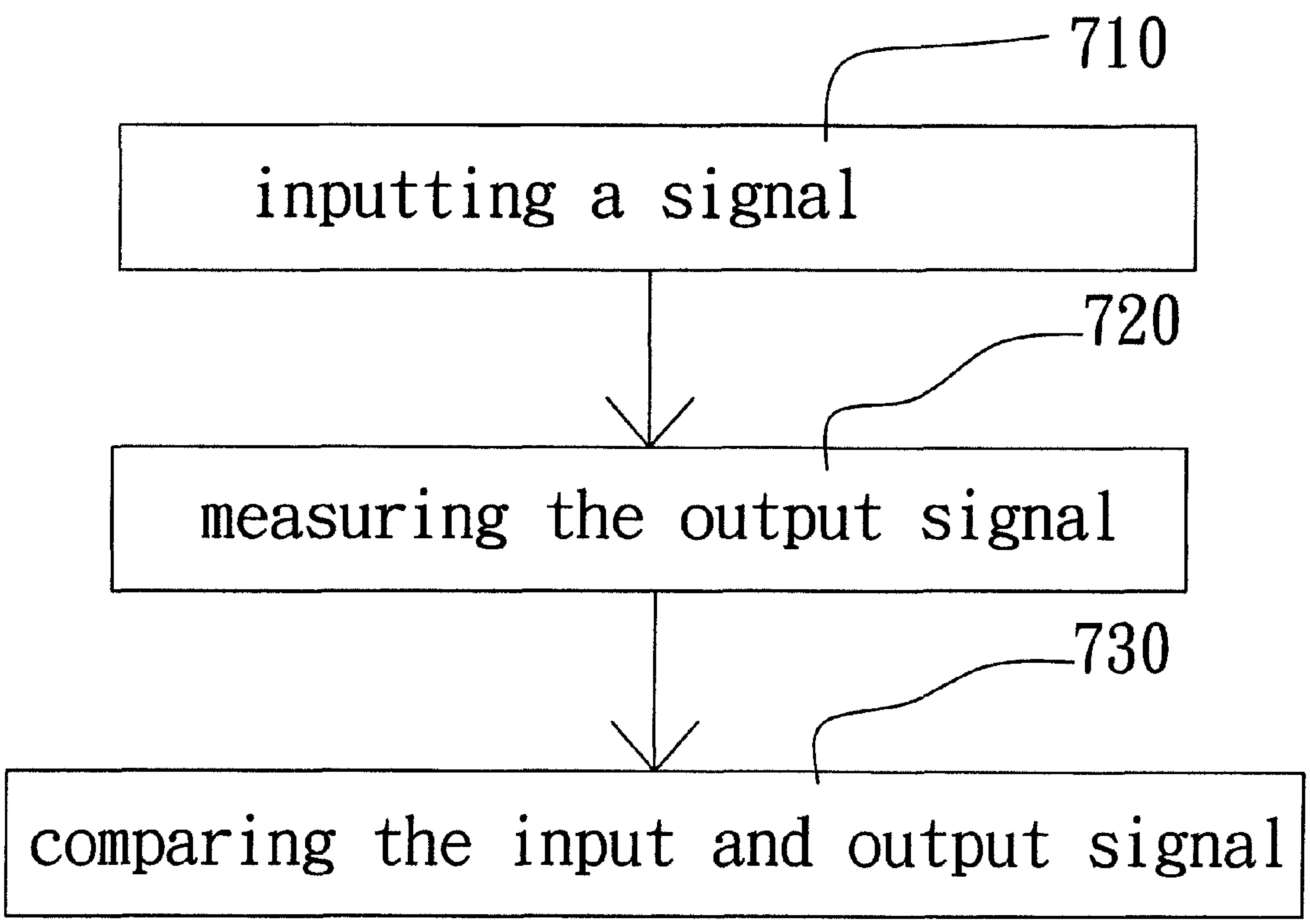

710
inputting a signal
720
measuring the output signal
730
comparing the input and output signal

Fig. 9

BONDING STRUCTURE OF CIRCUIT SUBSTRATE FOR INSTANT CIRCUIT INSPECTING

This invention is a continuation of application Ser. No. 11/905,439, filed on Oct. 1, 2007, now U.S. Pat. No. 7,919,782.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a bonding structure of two circuit substrates, and, more especially, to a bonding structure with instant inspection for reliability of circuit connection in bonding two circuit substrates.

2. Description of the Prior Art

FIG. **1** is a top schematic diagram showing the bonding structure between two circuit substrates according to a prior art. When two circuit substrates **10**, **50** are bonded, two circuits on the two circuit substrates **10**, **50** are electrically connected to each other via connecting wires **11** and **21** at the bonded interface between these two circuit substrates **10** and **50**. Especially, in assembling the display panel, such as the liquid crystal display (LCD), the organic electro-luminescence display (OELD) and the plasma display panel (PDP), the surface mount technique (SMT), tape automated bonding (TAB), chip on glass (COG) and chip on film (COF), the aforementioned technique are generally employed.

FIG. **2** illustrates the conduction principle of the circuits on circuit substrates **10** and **50**. The circuit on the circuit substrate **10** is covered by an insulating layer **41** and the end of the circuit is exposed to form the connecting wire **11**. The connecting wire **21** on the circuit substrate **50** is electrically connected to the circuit of the circuit substrate **10** via an anisotropic conductive film (ACF) **30**. The anisotropic conductive film **30** includes an insulator **31** and a plurality of conductive particles **32** distributed in the insulator **31**, and the conductive particles **32** are disposed of an insulating film on their surfaces. The anisotropic conductive film **30** is disposed between two connecting wires **11**, **21** and thermally compressed as the circuit substrates **10** and **50** are bonded. The insulating film is destroyed to conduct two circuits of these two circuit substrates via the connecting wires **11**, **21**.

In the prior art of TAB and COF, the material of the circuit substrate, which carries the integrated circuit (IC), is transparent, it assures the reliability of the circuit connection to observe whether the connecting wires are matched and the conductive particles between the connecting wires are deformed or not. But this technique cannot be applied to an opaque circuit substrate.

In a prior art, as shown in FIG. **3** and FIG. **4**, a connecting wire **130** on a circuit substrate has a chink **131** at the center. In assembling the two circuit substrates, the chink **131** is covered by the connecting wire **210** as shown in FIG. **3** if the connecting wires **130**, **210** are matched well, which indicates an validated circuit connection; and the chink **131** is pervious to light as shown in FIG. **4** if the connecting wires **130**, **210** are mismatched, which indicates a bad circuit connection. This prior art does not provide an instant method of inspecting the reliability of the circuit connection.

FIG. **5** is a schematic diagram showing another prior art, the dummy pads **140** and a window **141** are formed on two bonded circuit substrates respectively. The condition of matching the window **141** and the dummy pads **140** indicates the reliability of circuit connection of two bonded circuit substrates. But, this technique does not provide the instant inspection.

FIG. **6** is a schematic diagram showing the prior art, there are connecting wires **210**, **150** on two circuit substrates, wherein the connecting wire **150** has sidewalls on its both edges to form the bonding pads **151**. When the connecting wires **210**, **150** are thermally compressed, the amount of the conductive particles **32**, constrained between the bonding pads **151**, of the anisotropic conductive film is enough to avoid the conductive particles **32** spilling to damage the conduction. Again, this prior art does not provide the instant inspection.

The quality of connecting-wire connection affects the reliability of the circuit connection of two bonded circuit substrates, and the main two factors are whether the connecting wires are matched or not and contact quality of the anisotropic conductive film. The post-fabricated inspection is a big drawback in assembling two circuit boards. More especially, in assembling the LCD, it costs and spends much to measure white/black dots on the screen of the LCD for inspecting the reliability of the circuit connection after the LCD is assembled. An instant method of inspecting circuit connection in bonding two circuit substrates is essential for providing developers information and condition to modify the environmental parameters to enhance the reliability of the circuit connection.

SUMMARY OF THE INVENTION

For solving the aforementioned problems, one object of this invention provides a connecting-wire design of a bonding structure having an instant inspection ability of circuit connection in bonding two circuit substrates.

To achieve the above-mentioned objects, one embodiment of the present invention is to provide a bonding structure to bond two substrates, especially applied to assemble the circuit substrate of the liquid crystal display and the circuit substrate carrying the driving integrated circuit. The bonding structure includes a first circuit substrate having a first circuit, wherein the end portion of the first circuit comprises a plurality of first connecting wires transmitting signals separate from each other; a second circuit substrate having a second circuit, wherein the end portion of the second circuit comprises a plurality of second connecting wires transmitting the signals separate from each other and each second connecting wire, divided into a detecting part and a circuit part by a gap, is configured to be opposite to the corresponding first connecting wire for connecting the first circuit; and an anisotropic conductive film electrically connecting each corresponding first connecting wire and second connecting wire, wherein the anisotropic conductive film comprises a plurality of conductive particles and an insulator, of which the conductive particles have a diameter smaller than the gap on the second connecting wire, and before the anisotropic conductive film is applied between the first connecting wire and the second connecting wire, the detecting part of the second connecting wire are not electrically connected because of the gap; after the anisotropic conductive film is applied between the first connecting wire and the second connecting wire, the conductive particles respectively electrically connect the first connecting wire with the circuit part, and the first connecting wire with the second part, while the function of the gap insulating the circuit part and the detecting part is retained, so that flowing of the signal between the circuit part and the detecting part validates the first connecting wire being electrically connected to the second connecting wire.

The method of inspecting the circuit connection in bonding two circuit substrates with this kind of connecting-wire design is described as following: inputting a signal into the circuit part, measuring an output signal from the detecting part and comparing the signal inputted with the output signal.

In two bonded circuit substrates, the signal inputted at the circuit part passes the conductive particles to the first connecting wire, and then passes the conductive particles again to the detecting part from the first connecting wire. Therefore, measuring the output signal can inspect the reliability of the circuit connection of the bonded circuit substrates.

If the output signal is the same as the input signal, the bonding structure between the first connecting wire and the circuit part is validated, or, if not, the bonding structure is invalidated.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is the top schematic drawing showing the bonding structure between two circuit substrates.

FIG. **2** is the explored sectional drawing showing the bonding structure between two circuit substrates.

FIG. **3** is the schematic drawing showing the matched state of the bonding structure between two circuit substrates.

FIG. **4** is the schematic drawing showing the mismatched state of the bonding structure between two circuit substrates.

FIG. **5** is the schematic drawing showing the matched state of the bonding structure between two circuit substrates.

FIG. **6** is the sectional drawing showing the bonding structure in two bonded circuit substrates.

FIG. **7** is the explored sectional drawing showing the bonding structure between two circuit substrates according to an embodiment of this invention.

FIG. **8** is the sectional drawing showing the bonding structure between two bonded circuit substrates according to an embodiment of this invention.

FIG. **8***a* is the top perspective view drawing showing the bonding structure between two bonded circuit substrates according to an embodiment of this invention.

FIG. **9** is the flow chart showing the inspection method according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

As shown in FIG. **7**, a first circuit substrate **100** includes an alignment film **420**, a first circuit covered by the alignment film **420** (not shown in the figure) and an insulating layer **410**, where the end portion of the first circuit comprising a plurality of first connecting wires **110** transmitting signals separate from each other is exposed out of the insulating layer **410**. A second circuit substrate **500** includes a second circuit (not shown in the figure) and an end portion thereof comprises a plurality of second connecting wires **220** transmitting the signals separate from each other. Each second connecting wire **220** is configured to be opposite to the corresponding first connecting wire **110**. By a gap **223**, each second connecting wire **220** is divided into a circuit part **221** and a detecting part **222**.

An anisotropic conductive film **300** is disposed between each corresponding first connecting wire **110** and second connecting wire **220**. The anisotropic conductive film **300** includes an insulator **310** and a plurality of conductive particles **320**. Wherein, conductive particles **320** are distributed in the insulator **310** and each conductive particle **320** is disposed of an insulation film on its surface to form an insulated particle. Once the anisotropic conductive film **300** is thermally compressed, the insulation surface of the conductive particle **320** is destroyed so as to conduct the first connecting wire **110** and the circuit part **221**, and to conduct the first connecting wire **110** and the detecting part **222**.

The circuit part **221** is provided with a signal-inputted area **224** and the detecting part **222** is provided with a detecting area **510**. When the circuit part **221** and the detecting part **222** are an open circuit, the signal inputted at the signal-inputted area **224** may not be transferred or measured at the detecting area **510**. In order to confirm that the signal from the circuit part **221** does pass through the first connecting wire **110** to the detecting part **222**, the gap **223** should be wider than the diameter of the conduct particle **320** in the anisotropic conductive film **300**.

Referring to FIG. **7** and FIG. **8** for illustrating the conduction principle of the circuit. When the first circuit substrate **100** and the second circuit substrate **500** are thermally compressed, the insulation surfaces of the conductive particles **320** are destroyed to conduct the first connecting wire **110** and the circuit part **221**, and to conduct the first connecting wire **110** and detecting part **222**. However, the conductive particles **320** distributed in the gap **223** are not destroyed to remain insulation because of the diameter smaller than the gap **223**. Thus, the circuit part **221** is electrically connected to the first connecting wire **110** via the conductive particles **320**, and the detecting part **222** is electrically connected to the first connecting wire **110** via the conductive particles **320**. Therefore, the circuit connection of these two circuit substrates **100**, **500** can be validated by measuring the signal inputted at the circuit part **221** at the detecting part **222**.

FIG. **8***a* illustrates a corresponding top perspective view of the bonded structure between two bonded circuit substrates **100**, **500** illustrated in FIG. **8**. The sectional view shown in FIG. **8** is taken along the direction of the second connecting wire **220**. As shown in FIG. **8***a*, each of the first connecting wires **110** is connected to each of the second connecting wires **220** respectively. And in order to validate the electrical connection between each first connecting wire **110** and second connecting wire **220**, the second connecting wire **220** is divided into the circuit part **221** and the detecting part **222** by the gap **223**. The circuit part **221** and the detecting part **222** of the second connecting wire **220** are respectively connected to the first connecting wire **110** and the electrical conduction between the circuit part **221** and the detecting part **222** verifies the electrical connection between the first connecting wire **110** and the second connecting wire **220**. Note that in order to show the gap **223** in the second connecting wire **220**, the first connecting wire **110** on top of the gap **223** is not shown.

By accompanying FIG. **8** and FIG. **9**, the following explains the instant inspection method:

Step **710** is to input a signal at the circuit part **221** of the second circuit substrate **500**.

Step **720** is to measure an output signal at the detecting part **222**. The signal is inputted at the circuit part **221** of the second circuit (not shown in the figure) on the second circuit substrate **500**, and passes through the conductive particles **320** of the anisotropic conductive film **300** to the first connecting wire **110** on the first circuit substrate **100**. Then, the signal passes through again the conductive particles **320** of the anisotropic conductive film **300** from the first connecting wire **110** to the detecting part **222** on the second circuit substrate **500**.

Step **730** is to compare the signal inputted at the circuit part **221** with the output signal at the detecting part **222**. If the output signal is the same as the input signal, the bonding structure between the first connecting wire **110** and the circuit part **221** is validated, otherwise the bonding structure is failed.

This invention may be employed generally to the bonding structure of the bonded circuit substrates. Wherein, each of the circuit substrates is the insulation circuit substrate, such as the printed circuit board, plastic circuit substrate, glass circuit substrate or flexible circuit substrate, like the tape carrier package substrate, and so on. No matter what the bonded circuit substrates are transparent or not, the bonding structure can be employed to have the instant circuit connection inspection in bonding these circuit substrates to provide a higher reliability than that in the conventional eye-observation method.

For a liquid crystal display, even a flexible panel, the circuit substrate carrying the driving integrated circuit may be implemented as the first circuit substrate. The circuit substrate carrying the array circuit of the LCD may be implemented as the second circuit substrate. Once this invention is applied in bonding the two circuit substrates, the bonding structure of the display has the instant inspecting ability of circuit connection for the bonding structure.

Although the present invention has been explained in relation to its preferred embodiment, it is to be understood that other modifications and variation can be made without departing the spirit and scope of the invention as claimed.

What is claimed is:

1. A bonding structure of two circuit substrates, applied to a liquid crystal display module, comprising:

a first circuit substrate having a first circuit, wherein an end portion of the first circuit comprises a plurality of first connecting wires transmitting signals separate from each other;

a second circuit substrate having a second circuit, wherein an end portion of the second circuit comprises a plurality of second connecting wires transmitting the signals separate from each other, and each second connecting wire, divided into a circuit part and a detecting part by a gap, is configured to be opposite to the corresponding first connecting wire for connecting the first circuit; and

an anisotropic conductive film electrically connecting each corresponding first connecting wire and second connecting wire, wherein the anisotropic conductive film comprises a plurality of conductive particles and an insulator, of which the conductive particles have a diameter smaller than the gap on the second connecting wire, and before the anisotropic conductive film is applied between the first connecting wire and the second connecting wire, the detecting part of the second connecting wire are not electrically connected because of the gap; after the anisotropic conductive film is applied between the first connecting wire and the second connecting wire, the conductive particles respectively electrically connect the first connecting wire with the circuit part, and the first connecting wire with the detecting part, while the function of the gap insulating the circuit part and the detecting part is retained, so that flowing of the signal between the circuit part and the detecting part validates the first connecting wire being electrically connected to the second connecting wire.

2. A bonding structure of two circuit substrates according to claim **1**, wherein the first circuit substrate is a glass circuit substrate, a printed circuit board or a plastic circuit substrate.

3. A bonding structure of two circuit substrates according to claim **1**, wherein the second circuit substrate is a glass circuit substrate, a printed circuit board or a plastic circuit substrate.

4. A bonding structure of two circuit substrates according to claim **1**, wherein the detecting part comprises a detecting area.

5. A bonding structure of two circuit substrates according to claim **1**, wherein the conductive particles are disposed of an insulating film on the surfaces and distributed in the insulator.

6. A bonding structure of two circuit substrates according to claim **1**, wherein the material of the first connecting wire and the second connecting wire is copper or indium-tin compound.

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